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PERSONAL AND CIRCUMSTANTIAL FACTORS INFLUENCING THE ACT OF DISCOVERY.

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HOW STUDENTS SAY THEY LEARN WAS INVESTIGATED. INTERVIEWS WITH A RANDOM SAMPLE OF 74 WOMEN STUDENTS POSED QUESTIONS ABOUT THE NATURE, FREQUENCY, PATTERNS, AND CIRCUMSTANCES UNDER WHICH ACTS OF DISCOVERY TAKE PLACE IN THE ACADEMIC SETTING. STUDENTS WERE ASSIGNED DISCOVERY RATINGS BASED ON READINGS OF TYPESCRIPTS. EACH STUDENT WAS CLASSIFIED AND ANALYZED IN TERMS OF QUANTITATIVE TESTS OF FLEXIBILITY (ROKEACH DOGMATISM AND OTHER USES TEST) AND SECURITY (MASLOW SECURITY-INSECURITY TEST AND A SELF RATING). A MAJORITY OF STUDENTS REPORTED DISCOVERY EXPERIENCES. A CONCEPTUAL MODEL OF THE ACT OF DISCOVERY WAS DEVELOPED. IT WAS CONCLUDED THAT A PHENOMENOLOGICAL APPROACH TO THE STUDY OF THE DISCOVERY ACT IS FRUITFUL WHEN COUPLED WITH ADDITIONAL SOURCES OF INFORMATION ABOUT THE SUBJECTS. THE RELATIONSHIP BETWEEN ACADEMIC MOTIVATION, PERSISTENCE, AND VERBAL SKILL IS SUGGESTIVE ON AN INDIVIDUAL CASE LEVEL AND WARRANTS FURTHER STUDY. THE STUDY REVEALED THAT STUDENTS ARE INTERESTED IN THE EDUCATIONAL PROCESS. THE IMPORTANCE OF THE TEACHER AS DIAGNOSTICIAN, AND NOT MERELY EVALUATOR OF PERFORMANCE, WAS ALSO BROUGHT OUT. TEACHERS IN TRAINING MAY BENEFIT FROM A CONSIDERATION OF THE INDIVIDUAL STUDENT AS A COMPLEX OF INTELLECTUAL AND PERSONALITY VARIABLES WHICH INTERACT WITH CIRCUMSTANTIAL FACTORS. (SK)

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Introduction

This study investigates how college students say they learn. The dynamics of learning are revealed through personal interviews in which the students themselves describe their subjective or phenomenological experiences of how, when and where they "come to know". The process is conceived in interaction terms as an encounter between a learner and a teacher. The ideal result of such information exchanging encounters is a cognitive and affective experience in which the learner engages in the act of discovery.

The phrase, the act of discovery, became prominent in educational circles with its appearance in Jerome Bruner's book, The Process of Education, published in 1960. Bruner (12,13) defined this act as "the discovery of regularities of previously unrecognized relations and similarities between ideas." The act of discovery is not restricted to a relative handful of scientific and artistic creators. Everyone can discover. In fact, the act of discovery in the formal educational setting appears to provide the intrinsic motivation which fosters the desire to learn.

The first writings that followed Bruner's book were predominately non-empirical in nature. These included theoretical pieces, program outlines for elementary and secondary schools, and descriptions of the discovery process from the teacher's standpoint.

In contrast the present study is an empirical investigation using personal interviews to explore academic discovery experiences as college students subjectively view them.

The major purpose of this exploratory study is to consider the question: What personal and circumstantial factors in the college setting influence the student's experience of the act of discovery?

The four explicit objectives were:

1. Exploring student's personal reports of the act of discovery to determine appropriate and meaningful question wording for discussing the event.

2. Investigating the act of discovery in terms of its frequency and patterns of its occurrence.

3. Finding individuals who differ in frequency of discovery experiences in order to isolate circumstances which appear to facilitate or hinder the act of discovery.

4. Interviewing in depth and administering psychological tests to high and low frequency discoverers to provide empirical evidence which might suggest personal and circumstantial correlates of the act of discovery.

In summary this study sought to learn the answers to these questions:

Do students have discovery experiences of which they are sufficiently aware to verbally report them?

What do they call these experiences?

How often do they have them?

Is there any pattern of frequency or sequence?

Under what conditions do they occur?

Will detailed discussion with high and low frequency discoverers suggest correlates of the discovery act?

A brief review of theoretical writings and research findings from which this study originated will provide a context in which the outcomes can be reported.

1. The act of discovery as an essential feature of formal education is not merely a cognitive experience, but also encorporates an affective aspect. Whitehead(61) declared, "From the very beginning of his education, the child should experience the joy of discovery." Bruner (13) stresses the potential for intrinsic reward when expressing the problem of teaching for discovery. He says,

> Just what it takes to bring off such teaching is something on which a great deal of research is needed, but it would seem that an important ingredient is a sense of excitement about discovery. Discovery of regularities of previously unrecognized relations and similarities between ideas, with a resulting sense of self confidence in one's abilities.

This tone of personal growth through accomplishment personifies what White (60) has called effectance motivation. Maslow (36) describes peak experiences as moments of heightened sensitivity when perception is clearer and affective tone is high. Intellectual insights are included in a list of peak experiences along with religious, interpersonal, creative and athletic acts. Allen, Haupt, and Jones (2)

in a survey of peak experiences among female college students used Thorne's six category system. The highest rank (56%) was Cognitive Peak Experiences, Man against destiny: A) Growth experiences joy in growing up, finding oneself, becoming of age; B) Man in control of himself, performing at his highest. The second rank (14%) was what sound like academic discovery experiences. Cognitive Peak Experiences, Adventures of the mind: A) Understanding and discovery; B) Invention and creativity. Hopefully the academic setting will facilitate both types of cognitive experience.

2. Educational research is often so molar in orientation that frequently a situational variation constitutes the independent variable and grade point average the dependent variable.

In such a framework component or intervening processes such as the act of discovery are often ignored. Brown's (10) chapter on the interrelationship between personality, college environment and academic productivity illustrates the interactions and broadens the conception of productivity beyond mere grade point average. Abercrombie (1) developed a short training course for medical students which was directed at increasing their flexibility in diagnoses from available evidence.

3. Research on situational factors thought to influence educational outcomes are nomothetically focused and usually disregard individual differences in students even when the factors manipulated or dependent variables employed are innovatively chosen. Caro's (15) work on class attendance and course pacing does not look into personal factors. Beach(5) employs a variety of behavior changes in his research contrasting normal classes with leaderless groups, but within group variation is again ignored. Such studies as these point up the merit of investigating varied means of exposing students to educational experiences, but the moderator variables within the person may shed considerable light on the outcomes of such studies.

4. The student's discovery of relationships and regularities most frequently requires the understanding of knowledge that others before him originally recognized. Bronowski(9) contends that by hearing or reading about original discoveries an act of appreciation occurs which is a low key reenactment of the initial creative act. This view is significant in that it puts creative and appreciative behavior on a continuum. Research on creativity may be drawn on to aid in understanding academic acts of appreciation and discovery. Barron's (4) review

of personality correlates of creative behavior and MacKinnon's (30) intense personality study of creative scientists, architects, and writers offer a wealth of hypotheses of academic relevance.

5. Idiographically oriented research on creativity and learning offers suggests interactions between personal and circumstantial factors that may apply to the discovery act. Mackler and Shontz(32) enumerate individual differences in strategies employed by productive creative researchers. Restle, et. al. (43) show the importance of the open and closed mindedness variable on success in discovering how to solve different types of problems.

This exploratory study will seek, through interviews to unearth personal approaches to academic work which may facilitate discovery. Quantitative testing will provide some personality information on the same subjects.

METHOD

The 74 subjects were randomly drawn from the entire 900 member student body of Elmira College, a women's liberal arts institution.

Subjects received personal notes inviting them to participate as paid subjects in an investigation of "How students learn." Appointments were made and individual interviews followed a guided question sequence. (See Appendix A-1) The interview began with a discussion of outstanding teachers or vivid learning experiences which the student could recall. When a significant academic experience was identified, the questions focused on the student's description of the event and her reactions to it. As soon as the discussion permitted the fundamental question was posed: What do you call these experiences which occur when things that had not made sense come into focus and relationships formerly missing begin to form? Subsequent questions were directed to the frequency, time, place and patterns of such events. Students were encouraged to comment on factors that they felt facilitated or hindered the occurrence of these experiences. Explicit discovery experiences were discussed as critical incidents. These private interviews ranged from 30 to 90 minutes in length and were tape recorded. All interviewing was done by the male project director or his female college junior assistant.

Typescripts of the interviews were read independently by both the original interviewer and the other interviewer.

Subjects were classified into high, intermediate and low frequency discoverers. Discrepant cases were discussed and joint decisions reached.

The project director carried out a second interview with the high and low frequency discoverers. These taped interviews focused primarily on discovery experiences, the circumstances surrounding them, and the subject's affective experiences. (See Appendix A-4) Each subject completed a one-page questionnaire dealing with discovery experiences just prior to the interview. (See Appendix A-3) This procedure served to create a set on the part of the student and provided the interviewer with initial information for directing his questions. These tape recorded interviews lasted from 30 minutes to two hours.

At a separate session all 24 criterion group subjects and 21 middle group subjects completed Maslow's Security-In-security Test (34), Rokeach's Dogmatism Scale (46), a self and ideal self rating form and the other uses test. (See Appendix, A-5)

In addition student personnel records provided College Board Scores and the Colgate Personal Values Inventory (48, 49, 50) results for ninty percent of the participating subjects.

Results

The basic strategy in this research was to first understand the degree of student awareness of relationships and then uncover the words they used to discuss these events.

1. The majority of the students, 67 of 74 interviewed, could report at least one academic encounter, course, or experience in which they recognized a relationship or gained an understanding that had not previously been evident to them.

2. When asked what they would call such an experience in talking to someone about it, students gave 74 labels or phrases to describe these relationship experiences. (See Appendix B-1)

Of the 35 different terms or phrases used to describe what Bruner has called the act of discovery, some students suggested cultural cliches or everyday words like understanding, realization, relationship, and insight. Other unique terms, mentioned but once included e'lan, first-hand learning, sudden click and clash. (See Appendix B-1).

3. Frequency of discovery data defied quantification, but showed marked variability ranging from "daily" to "once or twice a year." Less precise reports of "constantly" or "seldom" were common. (See Appendix B-2).

4. Students were not equally explicit about discovery patterns. For given individuals a specific class, instructor or activity (i.e. studying for exams) was relevant. There is no clear evidence that discoveries occur massed or isolated.

5. Discovery appears as an affectively toned cognitive experience. Most students describe affective reactions accompanying discovery experiences. (See Appendix B-5).

6. Circumstances serving a catalytic function or accompanying discoveries are unique to the individual student. Class presentation is mentioned by half the sample, but non-class activities such as reading, writing papers, student discussions, and concentrated study are each reported by at least one-fifth of the sample. (See Appendix B-3).

7. Interview comments suggest high frequency discoverers are more intrinsically motivated by the academic tasks while low frequency discoverers expect teachers or custom tailored assignments to make them interested.

8. Tests of flexibility (Rokeach Dogmatism Scale and Other Uses Test) and instruments measuring security or worth (Maslow Security-Insecurity Test and Self Rating Scales) did not relate significantly to Discovery Ratings.

9. The CEEB-Verbal scores were significantly related to Discovery Ratings while the CEEB-Math scores were not. (See Appendixes C-5, C-6).

10. The Colgate Personal Values Inventory, a paper and pencil test of academic motivation, provided results which when combined with CEEB scores, Dogmatism and Security-Insecurity Test outcomes, offer promise in accounting for individual differences in discovery experiences.

11. Analyses of discovery experiences by college year indicate that variables other than years of academic experience are involved. Some freshmen are more active discoverers than some seniors. A higher proportion of low discoverers among sophomores may be a reflection of "sophomore slump." (See Appendix C-7).

12. Phenomenologically the discoverers have a more positive attitude toward academic activity than their peers who experience fewer discoveries. A statement of direction of causality cannot be made from the present data.

DISCUSSION

The model of man as an information seeker and processor has led many writers to focus on the interaction of the psychological processes:motivation, learning, and cognition. The convergence of authors beginning from such diverse positions suggests that the dynamics they are considering may be fundamental. In recent years these points of origin include: the educational process represented by Bruner(11,12,13) and Woodruff(63),curiosity motivation articulated by Berlyne(6,7,8),Solley & Murphy's writing on perceptual development(54), Schroder et.al.(51) on cognition, Maslow(35)dealing with personality and cognition and the efforts by Tomkins and Izard(56) to wed cognition and affect. In this vein the 1965 Nebraska Symposium reported Hunt's(24) work on intrinsic motivation and personality development and Guilford's (21) information psychology discussion. Sargant's(47)treatment of brainwashing reflects the same search for integration of processes in a physiological-social framework.

In each case the interaction of complex psychological processes is far from simple. The present research accepts MacLeod's(31) suggestion that a phenomenological orientation be used to look at complex psychological events; so we can ask the appropriate questions when we move to the laboratory. A phenomenological approach is difficult, often provides fuzzy evidence, and requires considerable time. Its virtue is the possibility of extremely fruitful leads.

The results have been reported; so this discussion will center on both data limitations and potentials. That 67 of 74 female Ss reported experiences that seemed to be recognitions of relationships or discoveries should be interpreted cautiously. Some were recollections from high school years; so they may not be discoverers currently. Academic discoveries are not easily separated from general maturing processes and events. The "cast a wide net" strategy was used to avoid missing academic discoveries. A tight definition of current, strictly academic discoveries is probably not what the data suggesting 90% discoverers means. Add to this the fact that some Ss may have tried to "give" the interviewer a discovery report since that appeared to be what was being sought and the possible inflation of the figure is clear.

Since discovery experiences are idiosyncratic & personal by nature, the wide range of terms and phrases reported is not surprising. Highly articulate and affectively sensitive students may have provided classifiable testimony while students less capable in those dimensions may have been effective but unclassified discoverers. Only skillful and perceptive interviewing can overcome

this problem.

Frequency data may also be contaminated by individual differences in subjective definitions of a discovery as well as articulateness and affective sensitivity. Many subjects did not appear to think of discoveries in a quantitative fashion, and few could provide numerically precise reports. Subsequent interviews revealed that, once sensitized, students reported more explicitedly. The present data does not provide clear quantitative parameters, though it does show considerable inter-individual variance in discovery frequency reported. A single fundamental pattern of discovery (i.e. streaks)was not evident in the data. The lack of a typology of patterns may have been a function, in part, of students' inability to settle on a definition of discovery that they could consistently apply. Regularities of discovery were reported as associated wity a given instructor, activity or place.

Students described both the affect accompanying their discoveries and the circumstances under which they took place without too much difficulty. An understanding of "personal affective semantics" is needed to interpret the magnitude of any student's discovery experience.

Comments on facilitating circumstances confirm the common sense observation that the impact of a class session depends on the student's prior preparation. Some prepared Ss said that a comment made in lecture bridged a gap in their reasonably ordered knowledge. Other students freely admitted their classroom insights resulted from their total lack of preparation. Phenomenologically these experiences are probably quite different. A large number of students considered intense personal preparation their discovery catalyst. They listed reading, writing papers and concentrated study as examples of this. Many students indicated that only the pressure of pending papers or exams would push them to the depth of immersion that made discovery possible.

High frequency discoverers appeared to be more motivated academically &/or more mature in their view of personal responsibility for learning. The less frequent discoverers were more willing to put the burden on the teacher "to make things interesting" before she would commit herself to intense study in that course. This difference in basic outlook not only appeared in the interviews, but was supported by the quantitative results of the Colgate Personal Values Inventory which will be discussed later in this report.

Psychometric data from tests of flexibility and security was collected on the assumption that flexible and secure Ss

would be more likely to see relationships and risk unique interpretations of information than would inflexible and insecure Ss. Work by Restle et. al.(43), Dunker(17), Katz,Sarnoff and McClintock(26), Lazarus and Alfert (29), Ray(41) and MacKinnon(30) all indicate that factors influencing flexibility and security have an influence on the fluidity of thought. The fact that none of the tests used(Dogmatism, Security-Insecurity, Other Uses and Self Ratings) were significantly related to discovery ratings may be due to a number of things. Invalid discovery ratings, small sample size or limited score range are all possibilities.

On the other hand the significant relationship between CEEB: Verbal and discovery ratings may be a function of the student's ability to articulate her discovery experiences and thus gain a high discovery rating rather than evidence of a valid causal link. CEEB:Math scores did not relate significantly to discovery ratings.

In addition to the CEEB data personnel records provided scores on the Colgate Personal Values Inventory for most students in the study. This paper and pencil test of academic values and motivation correlates close to zero with CEEB scores and averages around .50 with first semester college grade point average. This instrument includes two sub-scales which have particular relevance to this study. A Direction of Aspirations scale shows the degree to which the student says she is personally involved in struggling for successful academic performance. A Persistence scale shows "the extent to which a student is a hard worker. It has near zero correlation with scholastic aptitude. The persistence score is most predictive of academic success(of some 13 scales).

Instead of using the PVI data in statistical fashion, it was used to explore individual cases of high and low frequency discoverers for patterns. Schlesser (49,50)reports patterns of scores which predict underachievement. Low persistence and/or low academic achievement may be coupled with high CEEB scores and yet the student does poorly academically. One of the low discoverers in the present study was in the 85th percentile on CEEB:Verbal but below average(30th percentile)on persistence. Another discoverer in the low group was very high in academic motivation(95th percentile) and adequate on the persistence scale(40th percentile), but her CEEB:Verbal placed her in the 5th percentile. Another low frequency discoverer had a CEEB:Verbal in the 60th percentile, but a persistence score at the 10th percentile. These patterns are in keeping with the Colgate researchers' experience. On the other hand high frequency discoverers may not be higher in CEEB:

Verbal than some low frequency discoverers, but they are quite consistently persistent and strongly motivated academically. This pattern is especially clear for juniors and seniors. Another interesting pattern is found in the case of two high frequency discoverers. Both are above the 90th percentile in CEEB:Verbal and are above the median in academic motivation, but their security scores are much lower than their peers. It is a pattern that has the ear marks of "running scared" as students. In both instances their concerns are not intellectually or motivationally grounded, but the overt behavior has resulted in academic productivity and the ability to discover.

When this data on patterns is considered in light of the Act of Discovery Model (See Appendix D), it suggests that these tests may be measuring barriers that keep the student from discovering. In looking at the preparation phase of the model, the comments made in student interviews about being forced to become immersed is relevant. Getzels and Csikszentmihalyi(18) illustrate the significance of preparation for the creative artist and parallels to students' preparations can be drawn. The barrier concept is treated by Cohen(16), Pyke(40),and Rogers(44,45). Selye's(52) writing also illustrates the need for persistence as a scientific discoverer. The incubation period is imaginatively explored by employing group process in Gordon's writing(19), and Koestler(28) highlights the complexity of the creative process. Williams(62) cautions us in his writings to recognize the work discovery involves. Waterman(59) attempts to wed dissonance to classic motivation theory and provides a bridge to Berlyne"s ideas on uncertainty and information as serving motivational functions(6,7,8).

As an exploratory effort this phenomenological study has demonstrated the value in looking at the complex discovery event from a variety of viewpoints and with a range of empirical data.

CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

Conclusions:

A phenomenological approach to the study of the discovery act is a fruitful enterprise when coupled with additional sources of information about the subjects being studied.

More specific conclusions include: students can recognize discovery experiences and discuss them. There are large individual differences in actual frequency of discoveries reported, in sensitivity to them and verbal skill in articulating them. Discovery experiences involve unique circumstances along with interaction of

organismic variables. Standard tests of flexibility and security did not discriminate between students" discovery ratings. This outcome may be a function of methodological weaknesses. Verbal skill reflected in CEEB scores is correlated with discovery ratings and there may be an artifactual relationship here.

The relationship between academic motivation, persistence and verbal skill is suggestive on an individual case level, and merits further exploration.

Implications:

Working with these students in this study revealed that students are quite interested in discussion the process of education and not merely the content. The idea of mastering intellectual skills that have transfer value was especially appealing to the high frequency discoverers.

These interviews brought out the importance of the teacher as a diagnostician who helped students to surrmount their barriers and not just as an evaluator of their performance.

The Act of Discovery Model has potential for aiding teachers in the development of entire courses or individual class sessions. It provides a way of looking at the student in the academic setting as a dynamic, changing individual not as a static knowledge collector.

The quantitative test results viewed in the framework of the model and considered in both affective and cognitive terms suggests that the idea of the "whole student" be revisited.

Recommendations:

Teachers in training may well benefit from a consideration of the individual child or student as a complex of intellectual and personality variables which interact with circumstantial factors and that no simple formula can provide the sole solution to a teaching problem.

SUMMARY

This research explores the act of discovery as students phenomenologically view it. Interviews with a random sample of 74 students at an Eastern liberal arts college for girls posed questions about the nature, frequency, patterns and circumstances under which discovery acts take place in the academic setting.

Students were assigned discovery ratings based on readings of interview typescripts. High, middle and low frequency discoverers were classified, and analyzed in terms of quantitative tests of flexibility(Rokeach Dogmatism and Other Uses Test) and security (Maslow Security-Insecurity Test and a Self Rating).

Basic results showed that the majority of the students could report a discovery experience. There were wide differences in the labels used to describe the experience, the frequency with which these experiences took place, the circumstances under which they happened and the reports of affect accompanying the discovery experience.

None of the flexibility or security tests were significantly related to discovery ratings. CEEB Verbal scores did relate significantlly to discovery ratings,but this relationship may be an artifact of verbal facility. CEEB Math scores were not significantly related to discovery ratings.

The Colgate Personal Values Inventory, a paper and pencil test of academic values and motivation provided data which permitted pattern analysis of high and low frequency discoverers. These analyses indicated that an understanding of discovery acts requires a careful look at the individual case and that group analyses may hide significant relationships.

This research points up the virtue of molecular, phenomenological analyses of the learning process. It further indicates the importance of the teacher as a diagnostician rather than solely an evaluator.

A conceptual model of the act of discovery was developed to serve as a heuristic tool to be employed by teachers in their course planning and researchers interested in academic discovery.

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Act of Discovery Guided Interview Schedule

1. Introduction: tape, sample, goal of research

2. Favorite teacher:

   a) How acted - what generally did you like?
   b) What was significant -- usual, unusual?
   c) How made learning interesting?
   d) Other events with same teacher
   e) How did you feel?
   f) What did it mean?

3. Cognitive experiences - experiences with this teacher with which you struggled with an idea and suddenly it was clear as crystal? Hadn't made sense -- now all sorts of related ideas were clear. See the light at last.

   a) What experience?
   b) When -- when realize importance or relation?
   c) Where?
   d) Under what conditions?
   e) How did it feel (motivate-emotion)?
   f) Name you would give to this experience?
   g) Has this happened recently?

4. A recent experience of seeing the light -- most recent (same 3a-e questions)

   f) Generally when does this occur? night or in lecture or ?
   g) How often?
   h) How often during the week?
   i) Was this your most recent experience? If not recent, when was it?

5. Favorite class

   a) What you did?
   b) How you did it?
   c) What you have retained?
   d) Why was this outstanding?
   e) How differed from a course you hated?
   f) Any aids-visual, dramatic, etc.
   g) Experience of seeing relation not seen before?
   h) Question 3

6. Describe incidents to spur on

   a) George Washington Example
   b) What do you call this experience of knowing or feeling?
   c) Something similar happen to you?
   d) Question 3

7. Think of the most exciting experience you have had pertaining to learning - with a real emotional punch to it.

   a) Tell about it
   b) Why?
   c) How did it feel?
   d) What did it mean?
   e) Cause you to suddenly see light
   f) Name for experience?
   g) See Question 3

8. Do you ever keep a diary, not personal, but of events - try to capture what catches your eye

   a) Like what?
   b) When?
   c) Since when etc.
   d) What do you call these experiences of seeing light?
   e) Question 3

9. Consider yesterday or day before

   a) Any experiences as we have talked of them
   b) When?
   c) Where?
   d) How?
   e) Feeling
   g) Name

10. What do you do with your spare time?

11. Tooth paste dispenser

PRELIMINARY BACKGROUND INFORMATION

The purpose of these interviews is to follow up some of the ideas brought out in the earlier interviews in hopes of gaining a better understanding of why learning is sometimes exciting and effective while at other times it is dull and ineffective. All of us are learning new things every day. Sometimes it is how to do something--drive a car, take an interesting photograph. Other times it is to understand something we did not realize before like the role of a philosopher's thought in contemporary writing. Some of these things we learn easily while some come only after considerable effort. I am interested in your personal interpretation of some of your learning experiences -- what some of them have been, which ones were exciting and the people or situations which made them so.

To put you in a frame of mind that may help you to recall some of these experiences I raise some questions which you can answer on this sheet, then we will go on to discuss them.

1. We sometimes struggle with tasks or ideas that seem confused or unclear. Other times things are "just Greek to us" or seem beyond our comprehension. Then something happens -- by our doing something or someone else doing or saying it -- and the pieces fall into place or the confusion clears and the point is obvious and things have "jelled."

Can you recall having experiences like this?
( ) Yes ( ) No ( ) Not sure

2. What would you call such an experience? _____

3. These _____(name of experience given in #2) may vary in magnitude -- some are small or minor, and others are large and significant. Can you give an example of one that you felt was quite important or dramatic?

Issue or topic: Circumstances:

4. Can you think of a minor one?

Issue or topic: Circumstances:

5. Taking these two instances of _____ (name given the experience in #2) where would you place them on this line which represents degree of this experience?

---

low high

6. When was the last time you had such an experience?

( ) Within last 2 or 3 days ( ) Within last week

( ) Within last month ( ) within last 6 months

7. Considering both major and minor instances about how often do you have them?

( ) almost daily ( ) several times a week, ( ) about once a week

( ) every couple weeks ( ) once or twice a month

8. Under what circumstances do they occur? Check as many as apply.

( ) in class lecture
( ) in group discussion in class
( ) studying alone
( ) in bull sessions outside class
( ) while preparing for exams
( ) talking informally with faculty or adult friends
( ) other _____

9. Do these experiences occur in patterns (i.e. spurts or bunches) or not?

( ) Patterns or bunches ( ) isolated events

( ) both under different circumstances

10. Are there any habits or mannerisms teachers have or physical surroundings which you find so annoying or distracting that they inhibit your having the experiences we were considering earlier? Indicate briefly.

Act of Discovery Second Interview Schedule

1. Tell me about a recent_____(discovery) experience.
2. How would you go about doing a paper that is due in 4 weeks?
3. How many drafts would you make?
4. Does anyone read it and comment on it?
5. Are you able to set a target date and live with it?
6. How often do these_____(discoveries) happen?
7. Is there a pattern to their occurrence?
8. Are there certain places where they occur?
9. Are there certain hours of the day when you are more productive?
10. Does noise bother you?
11. What kind of notes do you take in class?
12. Do you prefer lectures which are read or spontaneously delivered?
13. Does the preparation or writing of exams aid learning?
14. What would you say are your strengths as a student?
15. What would you say are your weaknesses as a student?
16. Does your studying follow a regular time schedule?
17. Do you get immersed in plays, movies or novels to the point of bringing you to tears?
18. Do you have a favorite play?
19. Are these non-academic experiences basically like academic _____(discovery) experiences?
20. Can visual art create the same feeling?
21. How can a teacher facilitate discoveries?
22. What characteristics in people do you admire?
23. What does "being alive" mean to you?
24. Do you ever think of death?
25. Do you dream?

OTHER USES TEST

DIRECTIONS: The next form concerns your ability to think about common objects in a diversified manner. Take Test II, which is a dittoed sheet with numbers on it like this one I am holding up. Let me read the directions: "List other uses for a hanger. Quality, not quantity, counts on this test. We want to see how many good ideas you can produce within the given amount of time. You will be penalized for bad ideas." You will have six minutes to think up as many uses for a hanger as you can. Are there any questions about this? Ready, begin.

SELF RATINGS SCALES

DIRECTIONS: The next two pages are rating scales. These rating scales consist of 17 items, and are used in the following fashion: Let's say that the dimension we're rating is Happy-Sad. You will note that there are six lines between the words. If in describing yourself, you feel you are quite happy, then you would make an "X" on the line that is closest to Happy. If you feel you are quite Sad, you would make an "X" on the line that is closest to Sad. If you feel you are a shade more Happy than Sad, you would make an "X" here (show on blackboard). Answer each rating scale item by making an "X" on the appropriate line.

There are two parts: The first scale sheet is used in describing yourself as you are, the second scale sheet is for describing yourself as you would like to be. Upon completion of these sheets you can go on to the next test.

Instrument: The 17 item six-step rating scales were set up in semantic differential format.

First describe yourself as you ordinarily think about yourself.

Myself as I am

Generous _____: _____: _____: _____: _____: _____ Ungenerous

The other 16 items were: shrewd-wise, unhappy-happy, irritable-good-natured, humorous-humorless, sociable-unsociable, popular-unpopular, unreliable-reliable, important- insignificant, ruthless-humane, good-looking-unattractive, persistent-unstable, frivolous-serious, self-centered-altrusistic, imaginative-hard-headed, strong-weak, dishonest-honest.

The first term listed appeared on the left hand side of the scale. Positive terms were scrambled so the positive end of the scale was not always on the same side.

Table 1. Terms and Phrases Used to Describe Cognition of a Relationship (Act of Discovery)

	Frequency
Understanding: An understanding I hadn't had before; understood - all of a sudden it makes sense; complete understanding; really understand; gaining greater understanding.	13
Realization: Realize something; super realization; realizing what world is about.	10
Relationship: Relate it; relate; relate ideas	7
Revelation	4
See the light: light breaks; suddenly saw light	4
Insight: Gaining insights	4
Enlightenment	3
An awareness: A new awareness	2
Personal awakening: awakening	2
Single Mentions: First-hand learning; A'ha; Snapped into mind; Deeper meaning; Ideas more concrete; Recognition of the parts of the whole; See how things tie in; Clash; Digest and interpret material; Sort of dawns on me; Feel like you have expanded inside; Make the association; See something in another concept or presentation; Drawing your own conclusions; Wakes you up to reality; A new experience; Things become clear, made something clear; 'Elan; Suddenly it dawned on me; Broaden ing your experiences; Drawing forth; Confusion; Perception; Assimilated all the relationships & look at things as a whole;	26
No term mentioned	7
Clearly responded to interview suggestions	5
Total	86

Table 2. Reported Frequency of Discovery Experiences

	Frequency
Specific	
Every single class: a small revelation	1
Every Day: Could happen every day; about once/day little ones almost every day; I'm sure something happens every day that is a experience; big not frequently but smaller every day.	14
Not every day, but almost: quite often	1
Almost every lecture	1
Twice a week	1
A few times a week	1
More than 1/wk. in each course	1
Sometimes, not every day	1
Weekly: at least, about 1/wk.	3
One/Month-major: anytime-minor; one/month-big ones and 1/day smaller	2
Maybe 1/mon.	1
Two or 3 times/semester/course	1
Between 1/day and 1/semester	1
At least 1/semester: once or twice a semester	2
3/yr. - big ones	1
Not terribly often - 1 to 2/yr.	1
Every time I take an exam or concentrate	1
Non-specific	
Constantly	1
Happens all the time	3
Happens hundreds of times	1
Happens lots of times	1
Often: confusions happen often	3
Quite often: happens quite often; fairly often	4
Frequently	1
Not too often - once & awhile	1
Very infrequently	1
Seldom: I haven't related much since I've been here; not never - just seldom	2
Not often, not once in a blue moon	1
Never - all of a sudden	1
Its not happening	1
No Response	13

Table 3. Frequency Distribution of Circumstances Under Which Student Report Discoveries

Circumstance	Frequency
Class Lecture: lecture clarification; teachers comments	37
Reading	29
Writing Papers	26
Discussion Outside class, with teacher	21
Concentrated study alone: going over notes; doing homework, review	17
Class Discussion	15
Exam Preparation	12
Personal reflection: think alone	12
Taking exams	10
Lab work	6
Teacher posed questions in class	5
Fellow students motivated	5
Rereading	4
Post Exam Discussion of Performance	3
Illustrations in class	3
Circumstances mention twice: exchange programs; content variety; course coverage	6
Single Mentions: Present oral report; Discussion outside of class w/ teacher; Demonstration in lab; Visual Aids; Convo; Volunteer work; Systematic teacher; Prof interested; Related to life; Informal, less compelsit; Student teaching; Write notes out in language course; Projects	13
No Circumstances Reported	2

Table 4. Frequency Distribution of Number of Discovery-Provoking Circumstances Students Report

Number of Discovery-Provoking Circumstances	Frequency
Six	2
Five	5
Four	17
Three	30
Two	14
One	4
None	3

Table 5. Frequency Distribution of Affect Reported as Accompanying Discovery Experiences

	Frequency
Excitement: I got very excited about it; I get excited; excitement - almost exuberance; I got all hepped up about it; a sensation Wow!	17
Good: It just makes you feel good; you felt kind of good when you came out of class; makes me feel good; really feel good	14
Intellectually Bolstering: it made me feel smart or something; I feel very smart; you feel you've been exposed to some special kind of brilliance; I didn't feel so stupid you think you are good	10
Feeling of accomplishment: I feel that I have accomplished something; feeling of success mastering something you feel that you have gained something; feel like you've done something positive; have more confidence in myself	10
Satisfaction: I was pleased and satisfied; satisfaction; you appreciate things more; proud	7
Happy: I feel happy	6
Rewarding: Very rewarding; it has been worthwhile reinforced about my ability as a student	5
Surprise: surprised; I was so surprised	5
Interesting: really very fascinated	4
Odd: Like butterflies in your tummy; expanded inside; fantastic experience	4
Humorous: pretty funny; had to laugh - amusing to see so vividly; it kind of shocked me funny	3
Pleasant:	2
Relief:	1
Empathy:	1
No affect Reported:	6

Table 6 Frequency Distribution of Scores on Rokeach Dogmatism Scale

Score	Total	Highs	Lows	Middle
100-109	2		1	1
110-119	6	3	1	2
120-129	10	1	2	7
130-139	9	3	2	4
140-149	8		1	7
150-159	10	2	2	6
160-169	7	2	2	3
170-179	5	1	1	3

Table 7 Rokeach Dogmatism Scores for Total Sample and Subgroups

	Total	Highs	Lows	Middle
N	57	12	12	33
Mean	141.8	140.4	142.2	142.5
Median	141	135.5	144	141
Range	77	62	75	68
S.D.	19.41	20.79	21.51	17.91

Table 8 Median Test Frequency Data for Rokeach Dogmatism Scale vs. Discovery Ratings

	Discovery Ratings		
	High	Middle	Low
Closed-Minded 141-177	5	18	6
Open-Minded 100-140	7	15	6

NOTE: No significant relationships between Discovery Ratings and Rokeach Dogmatism Scale scores.

Table 9 Frequency Distribution of Maslow S-I Test Scores

Score	Total	High	Low	Middle
1-5	2		1	1
6-10	9		2	7
11-15	7	2	1	4
16-20	7	1	2	4
21-25	7	3	1	3
26-30	10	1	2	7
31-35	5	1	1	3
36-40	5	3	1	1
41-45	1			1
46-50	2	1	1	
51-55	1			1
56-60	1			1

Table 10 S-I Scores for Total Sample and Subgroups

	Total	High	Low	Middle
N	57	12	12	33
Mean	23.5	27.7	21.8	22.6
Median	22.5	26.5	20	23
Range	56	34	45	53

Table 11 Median Test Frequency Data for Maslow S-I vs Discovery Ratings

	Discovery Ratings		
	High	Middle	Low
S-1 Test			
23-58	7	17	5
2-22	5	16	7

NOTE: No significant relationship between Discovery Rating and Maslow S-I Test scores.

Table 12 Frequency Distribution of Other Uses Test Scores

Number of Uses	Total	Highs	Lows	Middle
15	2	2		
11	1			1
10	1			1
9	5	2	1	2
8	10	1	1	8
7	8	2	3	3
6	8	1	2	5
5	7		1	6
4	7	2	1	4
3	2			2
1	2		2	
No Data	3	2	1	

Table 13 Other Uses Test Scores For Total Sample and Subgroups

	Total	Highs	Lows	Middle
N	53	10	11	32
Mean	6.6	8.4	55.6	6.4
Median	7.0	7.0	6.0	6.0
Range	14	11	8	8
S.D.	2.68	3.69	2.45	1.99

Table 14 Median Test Frequency Data For Other Uses vs. Discovery Ratings

	Discovery Rating		
	High	Middle	Low
7 or more uses	7	15	5
6 or fewer uses	3	17	6

NOTE: No significant relationship between Discovery Rating and "Other Uses" test score

Table 15 Frequency Distribution of Self Rating Scores

Rating	Total	Highs	Lows	Middle
94	1			1
92	1			1
90	2	1		1
89	2			2
88	1			1
87	2		1	1
86	1		1	
85	3	1		2
84	2			2
83	3		2	1
82	6	1	1	4
81	3	1		2
80	3	1	1	1
79	1			1
78	4			4
77	2			2
76	3		3	
75	3	1		2
74	1		1	
73	1			1
72	1	1		
69	4	2	1	1
68	1		1	
67	2	1		1
62	1	1		
46	1			1
No Data	1	1		
N=	56	12	12	32

Table 16 Self Ratings for Total Sample and Subgroups

	Total	Highs	Lows	Middle
N	56	11	12	32
Mean	78.9	75.6	78.3	80.3
Median	81	75	80	82
Range	48	28	19	48

Table 17 Median Test Frequency Data: Self vs. Discovery Ratings

		Discovery Ratings		
		High	Middle	Low
Self Ratings	81+	4	18	5
	80-	7	14	7

NOTE: No significant relationship between ratings

Table 18 Frequency Distribution of CEEB: Verbal Scores

Score	Total	High	Low	Middle
250 - 299	1			1
300 - 349	1			1
350 - 399				
400 - 449	3			3
450 - 499	8		3	5
500 - 549	12	1	2	9
550 - 599	13	3	3	7
600 - 649	12	4	3	5
650 - 699	6	3	1	2
700 - 749	1	1		

Table 19 CEEB: Verbal Scores for Total Sample and Subgroups

	Total	High	Low	Middle
N	57	12	12	33
Mean	559.1	627.4	559.3	534.3
Median	570	618	573	541
Range	447	156	213	428

Table 20 Median Test Frequency Data for CEEB - Verbal vs. Discovery Ratings

	Discovery Ratings		
	High	Middle	Low
572 - 702	11	12	6
255 - 568	1	21	6

NOTE: There is a significant relationship at the $p=<.01$ level between CEEB:Verbal and Discovery Ratings.
$X^2 = 10.79$ df=2 $p=<.01$

Table 21 Frequency Distribution of CEEB: Math

Score	Total	High	Low	Middle
250-299	1			1
300-349				
350-399	3	2		1
400-449	2	1		1
450-499	8	1		7
500-549	12	1	4	7
550-599	17	3	6	8
600-649	9	1	1	7
650-699	5	3	1	1

Table 22 CEEB: Math Scores for Total Sample and Subgroup

	Total	High	Low	Middle
N	57	12	12	33
Mean	542.2	547.7	569.6	535.4
Median	558.5	576	561.5	531.5
Range	424	314	161	424

Table 23 Median Test Frequency Data for CEEB: Math vs. Discovery Ratings

		Discovery Ratings		
		High	Middle	Low
CEEB Math	561-694	7	15	7
	270-556	5	18	5

NOTE: No significant relationship between Discovery Rating and CEEB: Math

Table 24 Proportions of Population Interviewed and Tested

Class	Total Population		Sample Interviewed		Sample Tested	
	#	%	#	%	#	%
Freshman	361	35	33	44.6	27	47.4
Sophomore	241	24	16	21.6	12	21.1
Junior	227	22	15	20.3	9	15.8
Senior	185	18	10	13.5	9	15.8
N	1014		74		57	

Table 25 Tabulation of Class and Discovery Ratings

Class	Discovery Rating High	Middle	Low	Total
Freshman	3	1	3	27
Sophomore	3	4	5	12
Junior	3	4	2	9
Senior	3	4	2	9
N	12	33	12	57

A Conceptual Model of the Act of Discovery

NOTE: This brief account of the conceptual model of the Act of Discovery is taken from a paper presented at the Eastern Psychological Association Convention meeting in Boston, Massachusetts on April 8, 1967.

Let us now consider the dynamics of the act of discovery. (Refer to Figure 1 The Conceptual Model of the Act of Discovery.) This model represents the act of discovery in a time sequence as a product of teacher-learner interaction. The sequence moves from the left to the right of the figure. Across the top of the page, immediately under the title of the figure, you will see the labels assigned to the five phases of the act of discovery. Preparation, futility at the conscious level, incubation, discovery and verification are basically the names given to the steps in creative thinking which Wallas assigned back in the 1920's. John Dewey's writing on human thought processes employs the same fundamental concepts.

The first feature of the model is the contention that the student's act of discovery proceeds over time and follows the same sequence as an act of creative thought. The five vertical lines running down the whole page show the divisions between phases. The phases vary in width to suggest that each of the phases are not representing time periods of the same length. If Edison's observation, "Genius is one percent inspiration and ninety-nine percent perspiration" is meaningful, then the discovery time period should be proportionately shorter. Longer preparation time may be needed if we are unfamiliar with an area of knowledge, such as a new course in college. For any given teacher-learner pair and for any specific topic the width of the phases may vary.

The arrowhead funneling from preparation to discovery is intended to represent the student's sharpening of her focus as she closes in on the discovery experience. The wide arc from discovery to verification is intended to depict the transfer of the discovery principle to a wider range of experience than the one from which it originated.

Looking at the array of converging inputs in the preparation phase we see the typical materials a teacher selects to facilitate student learning-text, readings, lectures, films, and field trips. The student must become steeped in the material if she is to grasp the relationships inherent in the field of study. Relevant here is the quote by Carl Rogers, "As a teacher, I cannot teach, I can merely facilitate learning." The facilitation he speaks of may include the teacher's selection of well-written, penetrating, current texts and supplementary readings in contrast to the hindrance of poorly chosen material.

Note, however, that it is the student who must learn; the teacher cannot accomplish this for her. In the preparation stage the teacher chooses inputs expected to provide a range of stimulating, dissonance-producing information. The student must master and integrate this information if she is to move from mere rote memory to a fuller comprehension.

Looking at this phenomenologically, as a student, the initial reaction to this diverse information may be a feeling of confusion. We've all had the experience when confronted with a new course, or theory of saying, "I don't get it, what is he talking about?" This is what the phase of the model labeled "Futility at the conscious level" refers to.

We now have a student confronted with a range of information from a number of sources. Berlyne tells us that information gives rise to uncertainty and this in turn leads us to seek additional information to reduce the uncertainty. This conflict created by dissonant inputs is motivating. Piaget speaks of the condition of disequilibrium as the propelling force which drives the child to attempt to explore in an effort to make sense out of its chaotic environment.

Therefore, we might ideally expect that exposing a student to diverse and conflicting sources will generate intrinsic motivation to reduce uncertainty. Festinger would characterize this as a condition of cognitive dissonance leading to action.

Recall I said that ideally this happens. When it does, the student behaves appropriately by asking questions, re-

reading assignments and perhaps moving directly to a discovery.

But let's look at the more typical case. The vertical lines irregularly spaced within the futility phase of the model represent barriers within the student. These may be items normally called personality factors. There may be many barriers or there may be few. They may be thick and difficult to penetrate or tissue-paper thin and non-resistant. Barriers may include: fear of failure, rigidity, lack of motivation, limited intellect, poor study habits and lack of confidence.

According to Berlyne when the information creates too great a feeling of uncertainty and conflict, the organism may withdraw from the confrontation rather than seek information that might reconcile the uncertainty. This overwhelming uncertainty creates a stressful situation and may foster rigidity or other forms of non-productive behavior.

What this model suggests and the data supports is that some students seek discordant information because they like to bring order to the new field of study they have encountered. The quote, "I like psychology because I know so little about it that I'm learning new things everyday" shows a case where conflict is sought and enjoyed. That student discovers and pursues new uncertainties with the expectation that the subsequent affective charge will be repeated. In contrast to the seeker is the conflict avoider. She freezes or malfunctions under conditions of uncertainty. This student confronts Freud's <u>The future of an illusion</u> not as a source which challenges her religious beliefs thereby helping her to clarify her personal philosophy, but as an effort by the teacher or institution to undermine her life-long, probably unscrutinized, values.

This conception of teacher-directed information input interacting with the student's level of productive or destructive arousal explains a common academic phenomenon. Most advisors have encountered a student who "swears by" a given teacher and his methods while another student in the same class sees the teacher as incompetent to teach her anything. Sometimes the "gentle, good joe" instructor can maintain a specific student's attention and present conflict-inducing material in such an unthreatening way that the

student will explore rather than panic. With that same student a demanding task-master type of instructor would immobilize her. It appears that such gross cliches as "If the student hasn't learned, the teacher hasn't taught" are sheer nonsense. This would be true not only in cases where students did not learn, but even in cases where the student did learn. I might say, in spite of the teacher. We have all had one or two students during our careers who could master the course content in depth if you merely gave them the syllabus and left them to their own devices.

Returning to the third phase of the model, the incubation phase, we are referring to the back-burner perking of the inputs. This phase is considered by many writers a strictly unconscious phenomenon. Work such as Gordon's on synetic discussions indicates that incubation need not be completely beyond conscious control.

Upon succesful completion of the incubation phase the diverse elements fall into place and the act of discovery is experienced. The relationships become vivid and obvious. A positive affect accompanies the tension reduction and a sense of elation and personal satisfaction is felt.

Having recognized the relationship, the final phase is the test to confirm the validity of the discovery by means of drawing on new facts or applying the discovery principles in a different setting. This validation procedure may take many forms. Discussion, reading, observation or merely further reflection are alternatives commonly employed. Once the individual has confirmed the discovery to her satisfaction, this awareness becomes part of her cognitive system. Her future interpretation of relevant inputs will be influenced by that discovery.

Figure 1 Conceptual Model of The Act of Discovery